Update on MOD 17 GPP/NPP And MOD 16 ET

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MODIS Science Team Meeting

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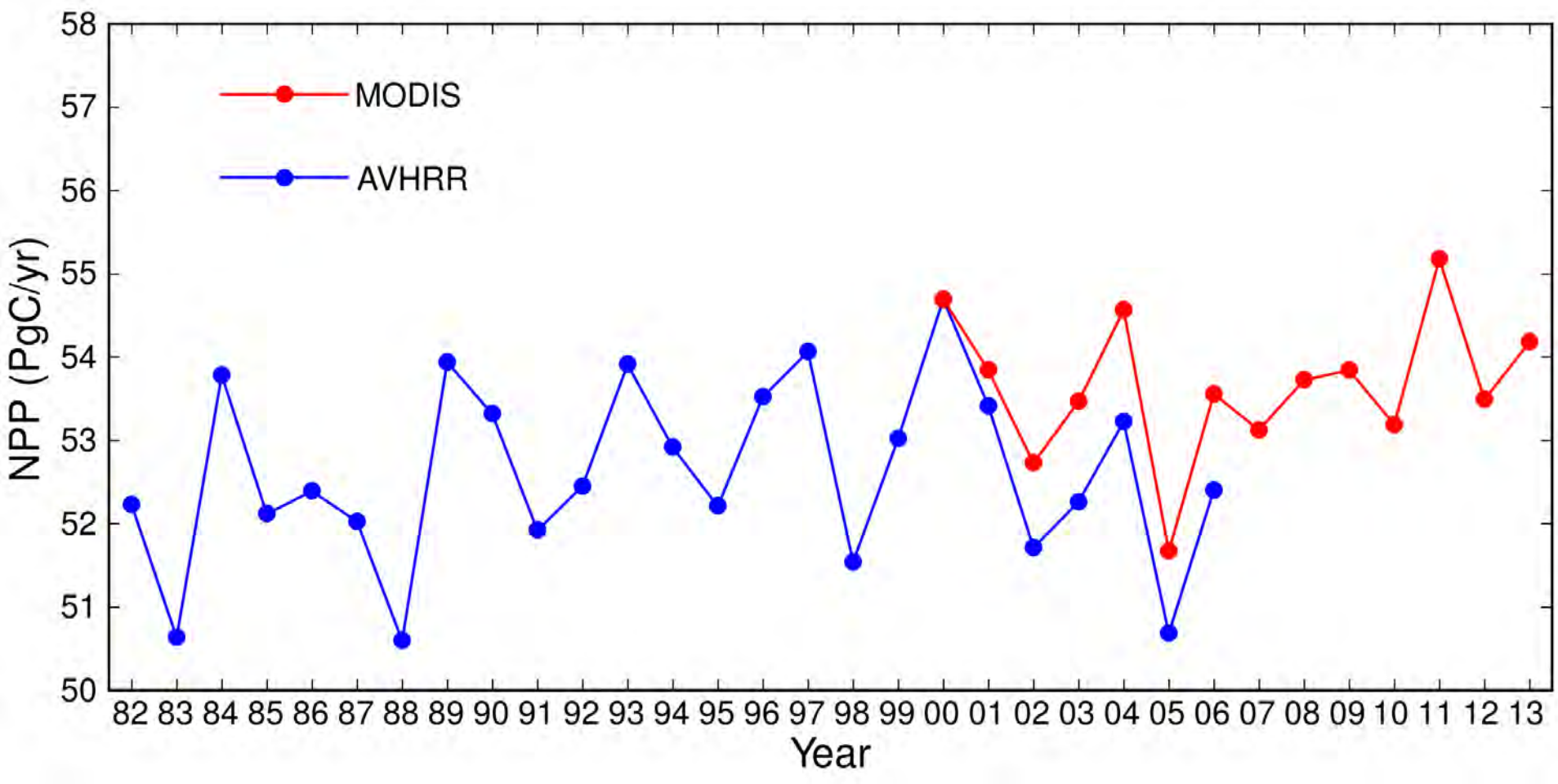
Global Terrestrial Net Primary Production (1982-2013)



+/- 1Pg or about 2%

Nemani et al 2003, Zhao and Running 2010

ENSO Dynamics Controlling seasonal MODIS GPP

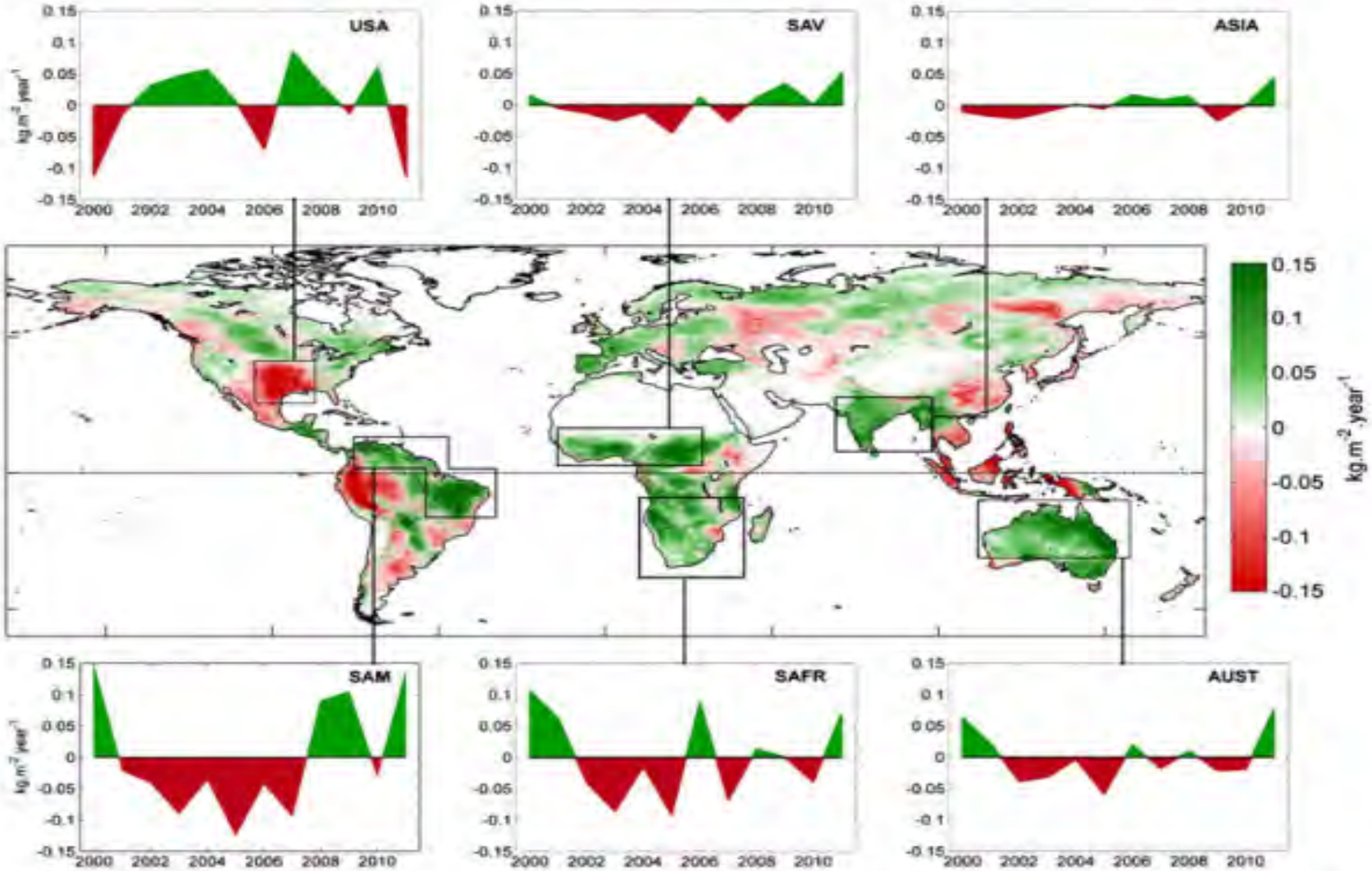


Figure 2. Global NPP anomalies in 2011 and NPP variability in selected regions. Global NPP_{anom} field in 2011 in kg m^{-2} $year^{-1}$ and the evolution of NPP_{anom} over the period 2000–2011 computed in regions with very high absolute anomalies during 2011.

Bastos, Ana et al. 2013 JGR Biogeosciences

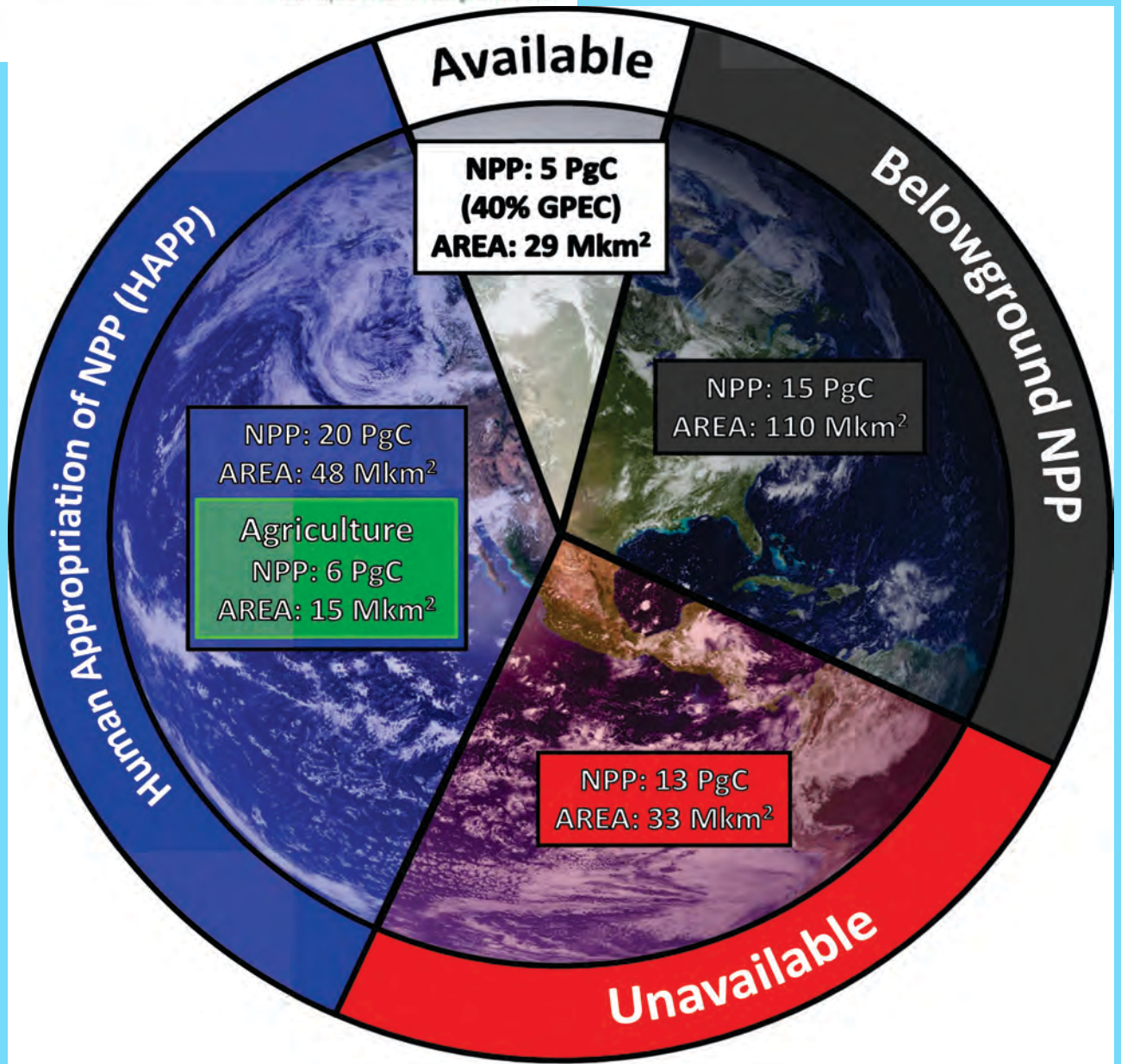
ECOLOGY

A Measurable Planetary Boundary for the Biosphere

Steven W. Running

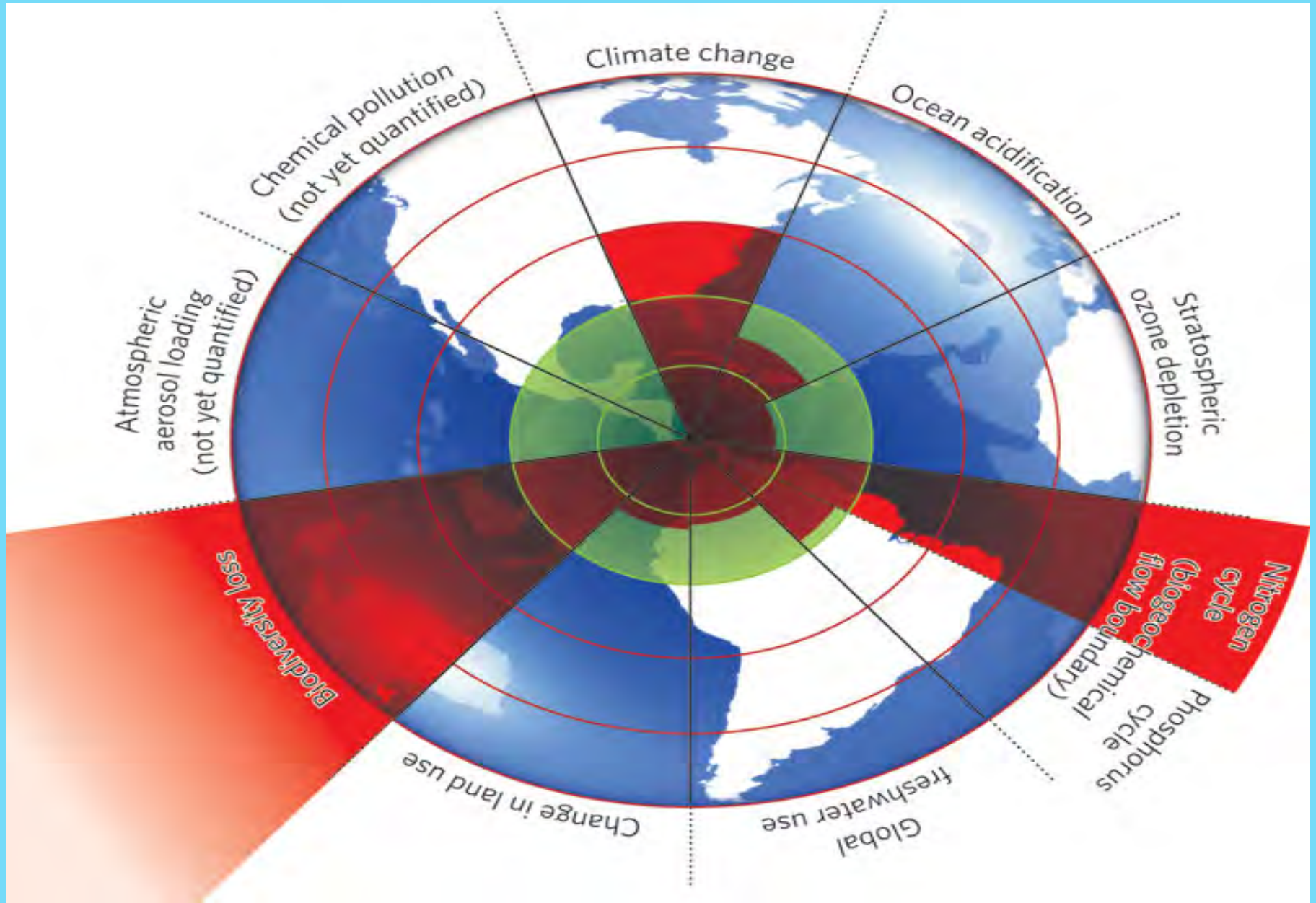
Terrestrial net primary (plant) production provides a measurable boundary for human consumption of Earth's biological resources.

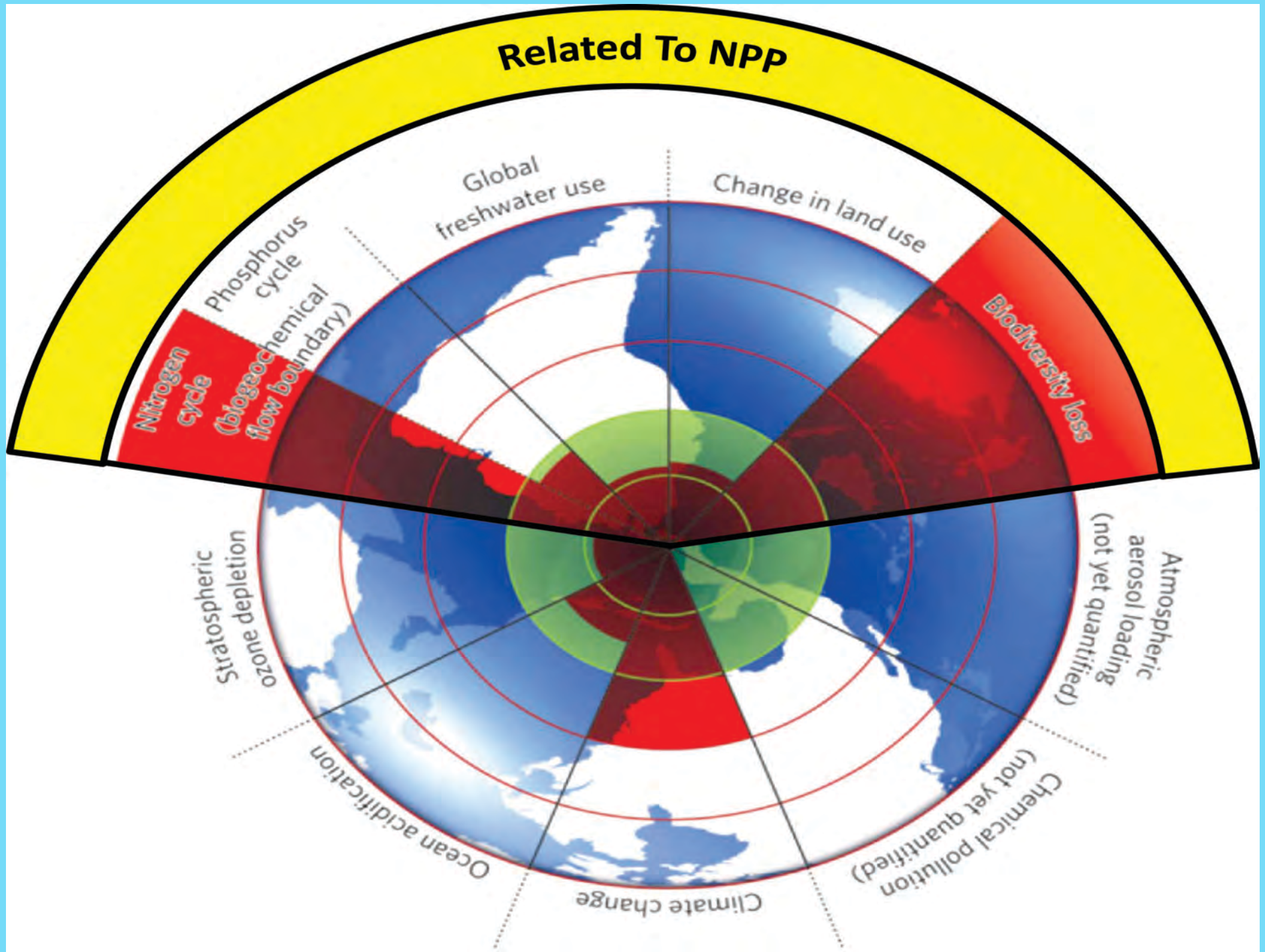
From Running, SW. *Science* 337 p1458-1459, 2012



PLANETARY BOUNDARIES

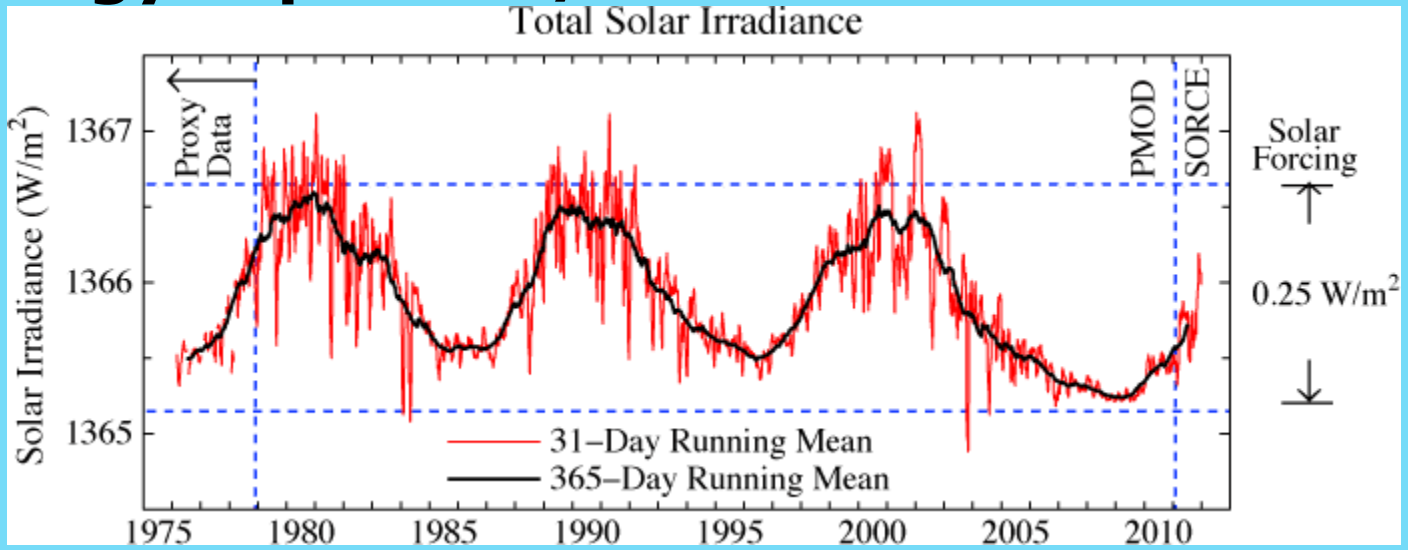
Rockstrom et al. *Nature* 2009



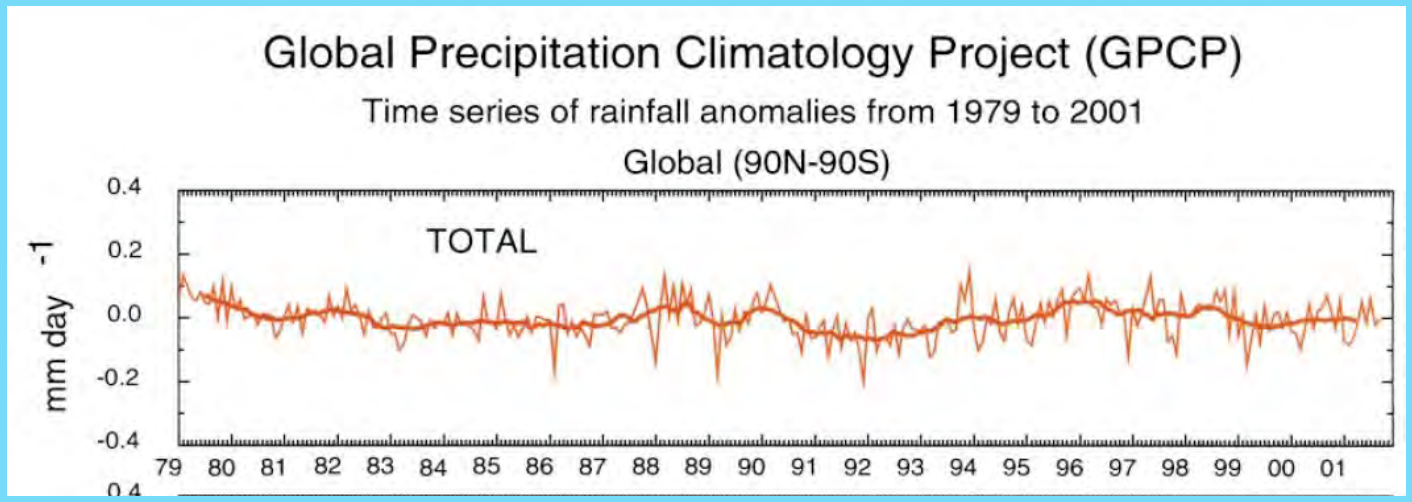

Related To NPP
Global freshwater use
Change in land use
Phosphorus cycle
Nitrogen cycle (biogeochemical flow boundary)
Biodiversity loss
Stratospheric ozone depletion
Atmospheric aerosol loading (not yet quantified)
Ocean acidification
Chemical pollution (not yet quantified)
Climate change

DRIVERS HAVE LITTLE INTERANNUAL VARIABILITY

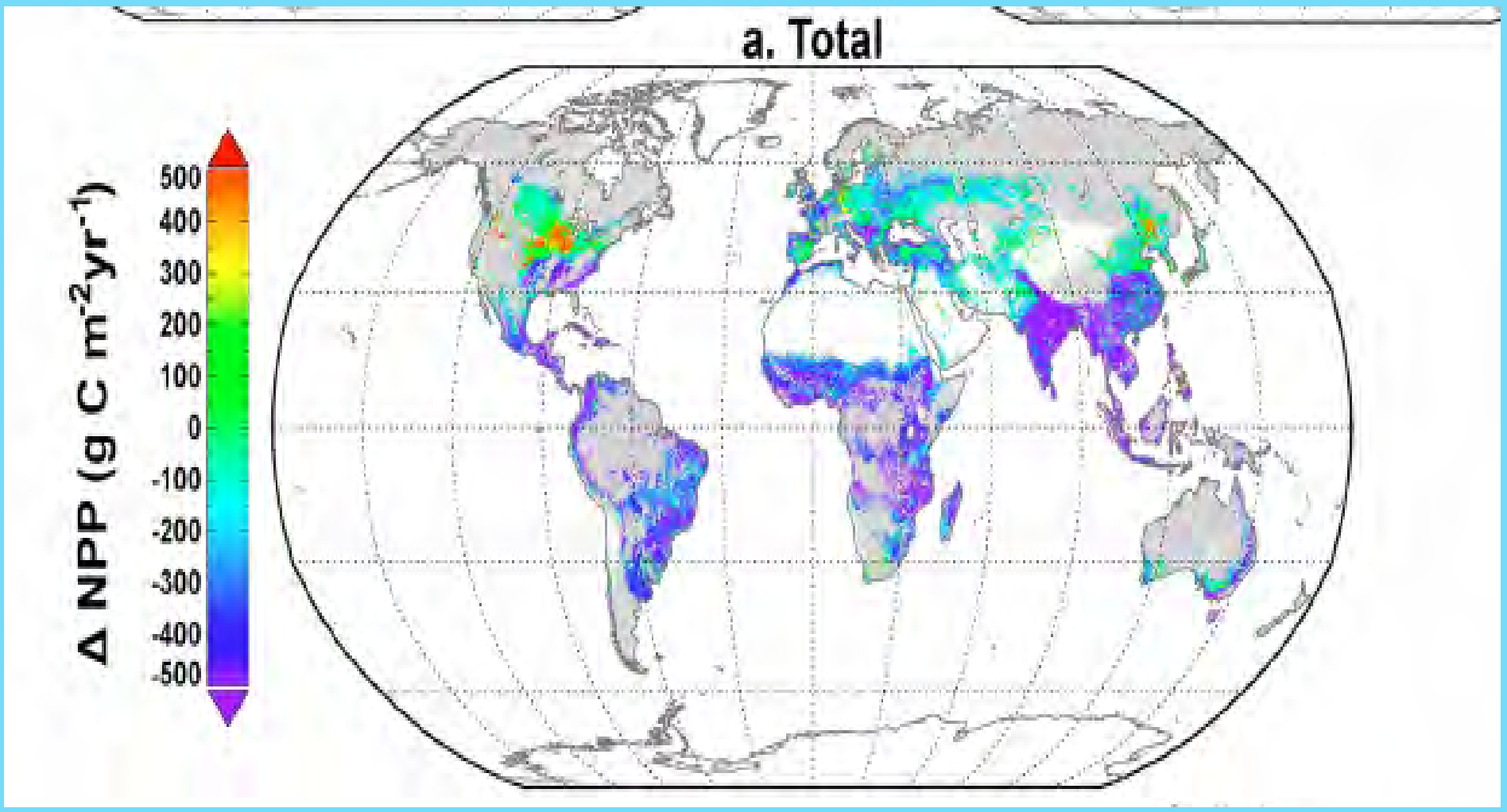
Solar Energy Input = +/- 0.1%



Global average precip = 2.6 +/- .1mm/Day or 4%

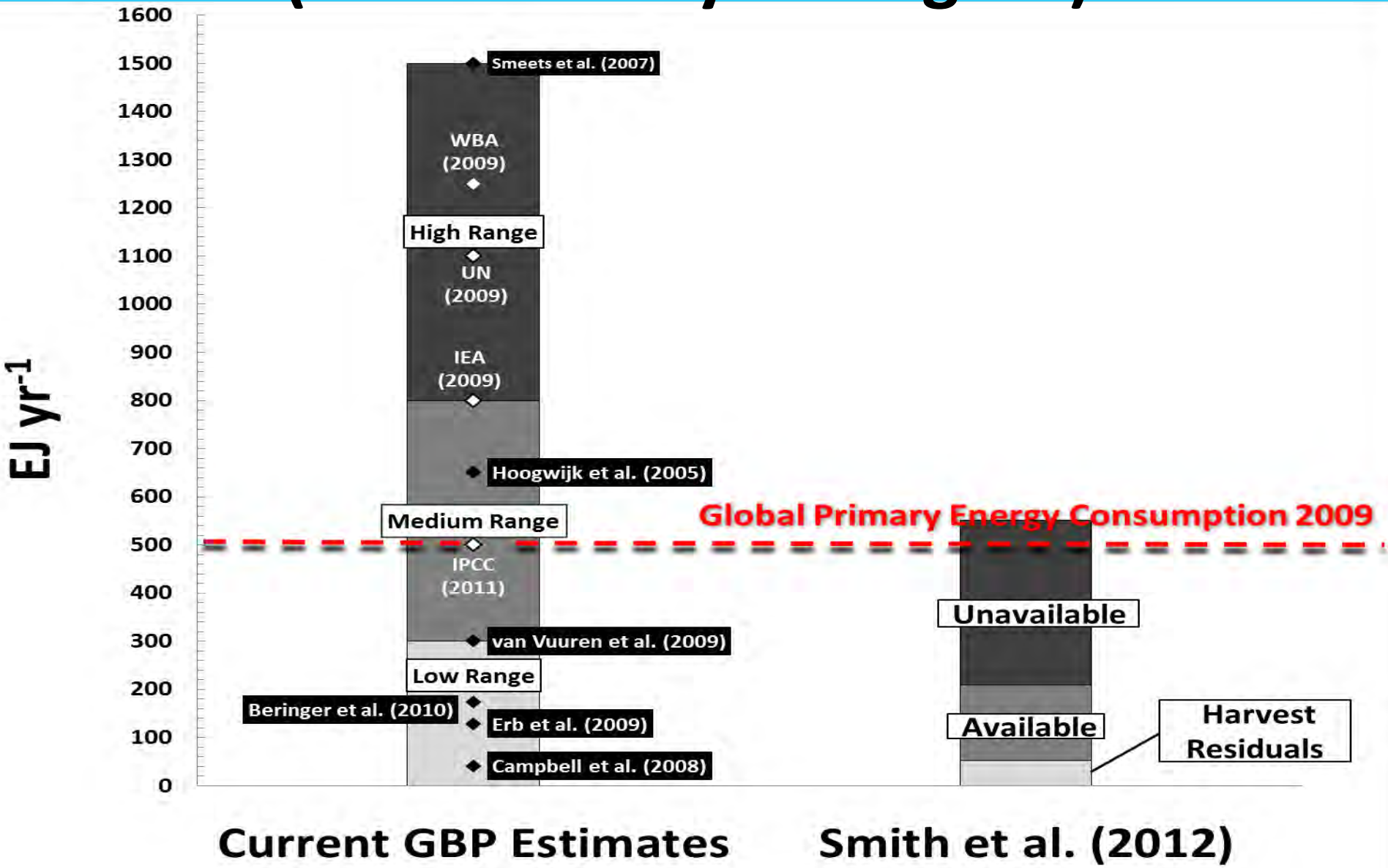


Global NPP has been reduced by 7% from agricultural conversion



Smith W.K. et al 2014 Geophys Res Letters.

Capacity for Bioenergy Production (estimated by ecologists)



CO2 Fertilization
5 Flux towers

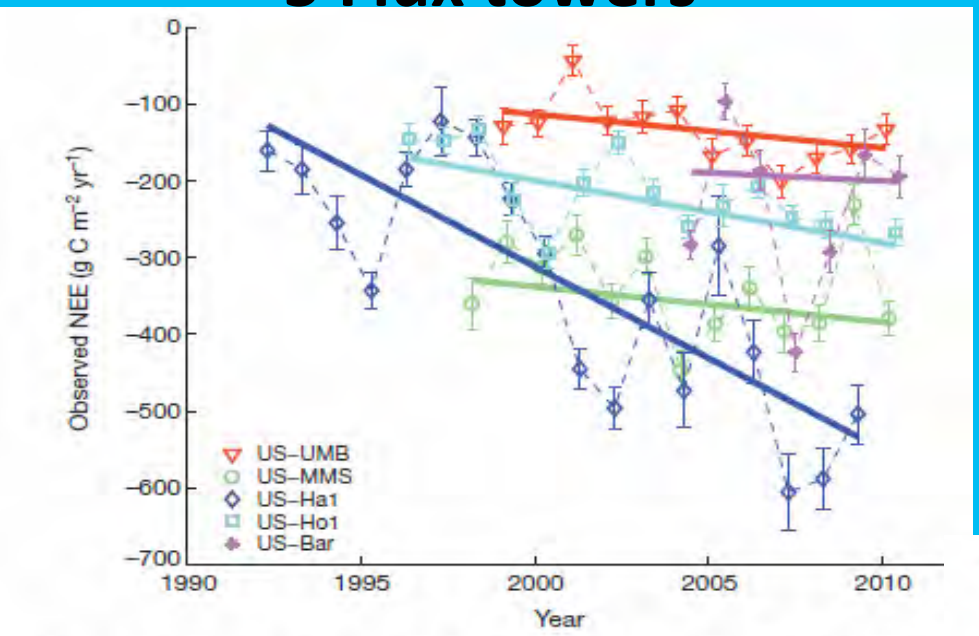
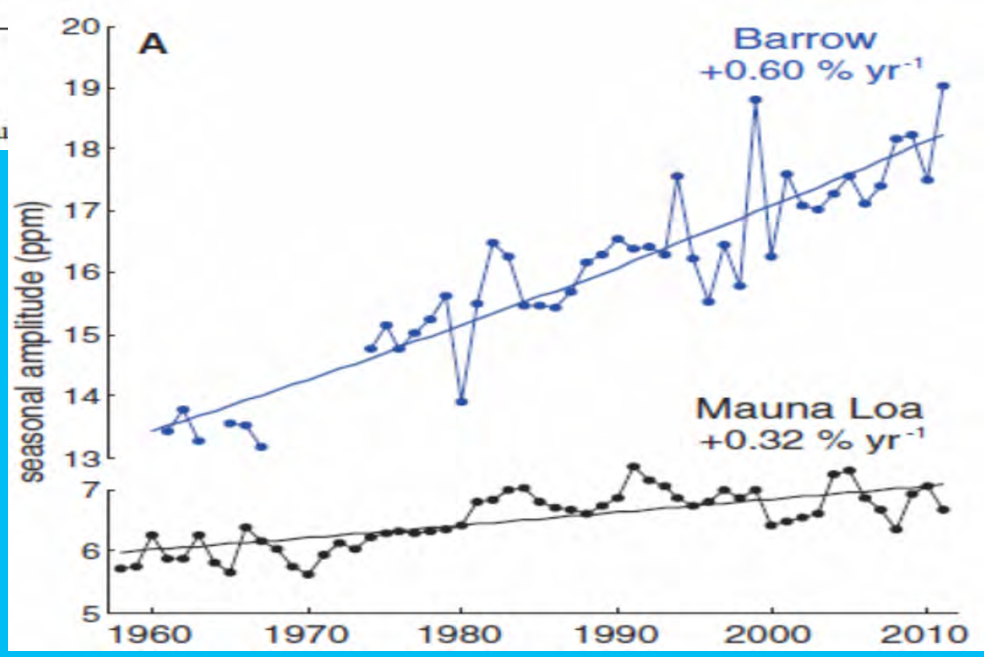


Figure 3 | Long-term increase in net ecosystem carbon uptake. The annu

Keenan et al. Nature 2013

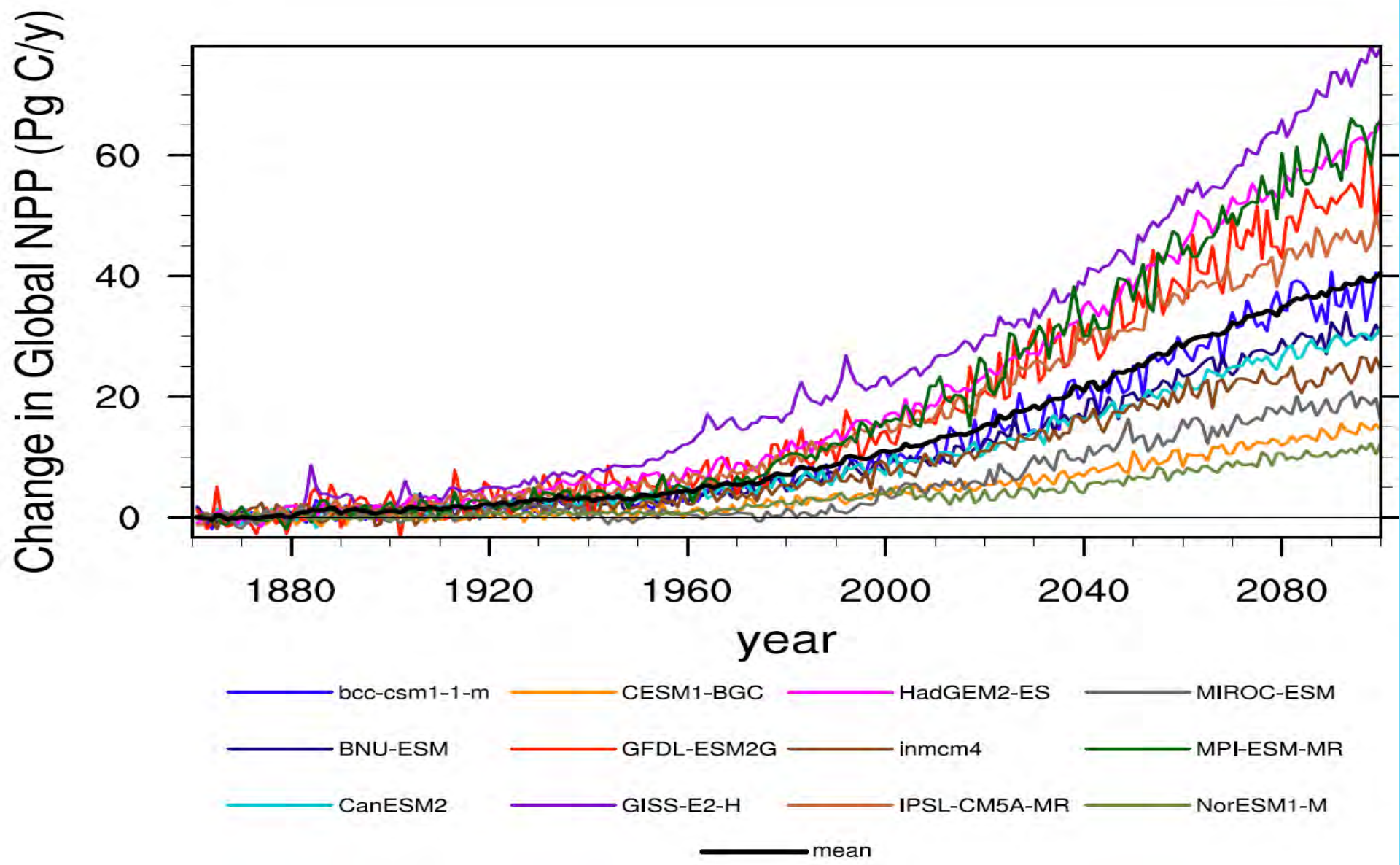
BUT, Contradictory Evidence???

CO2 Amplitude Increase



Graven et al Science 2013

CMIP5 Projections of Global NPP with RCP = 8.5. Really???



Fate of Anthropogenic CO_2 Emissions (2003-2012 average)

8.6 ± 0.4 GtC/yr 92%

0.8 ± 0.5 GtC/yr 8%

+

4.3±0.1 GtC/yr
45%

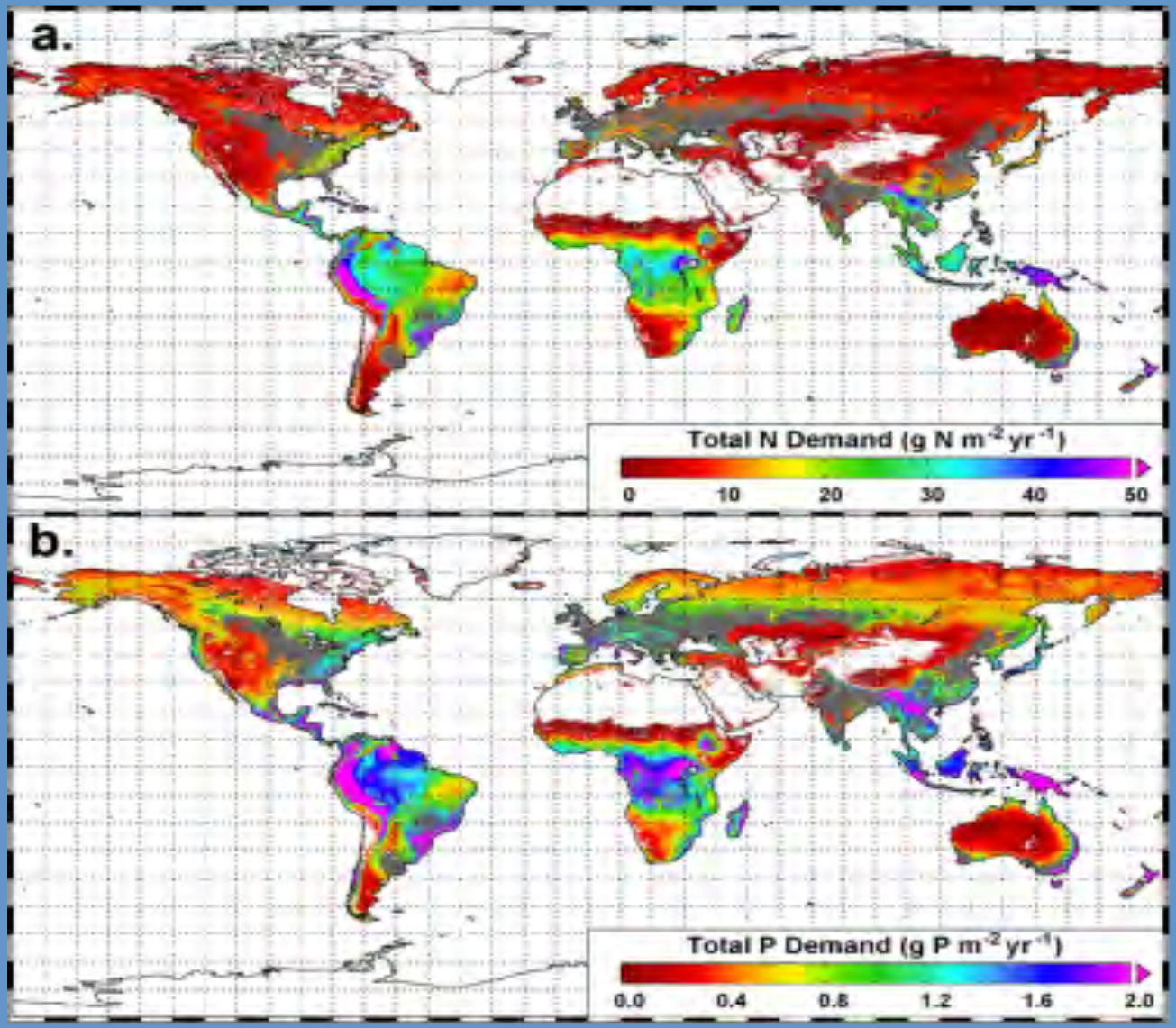
2.6 ± 0.5 GtC/yr
27%

2.6 ± 0.8 GtC/yr
27%

Calculated as the residual
of all other flux components

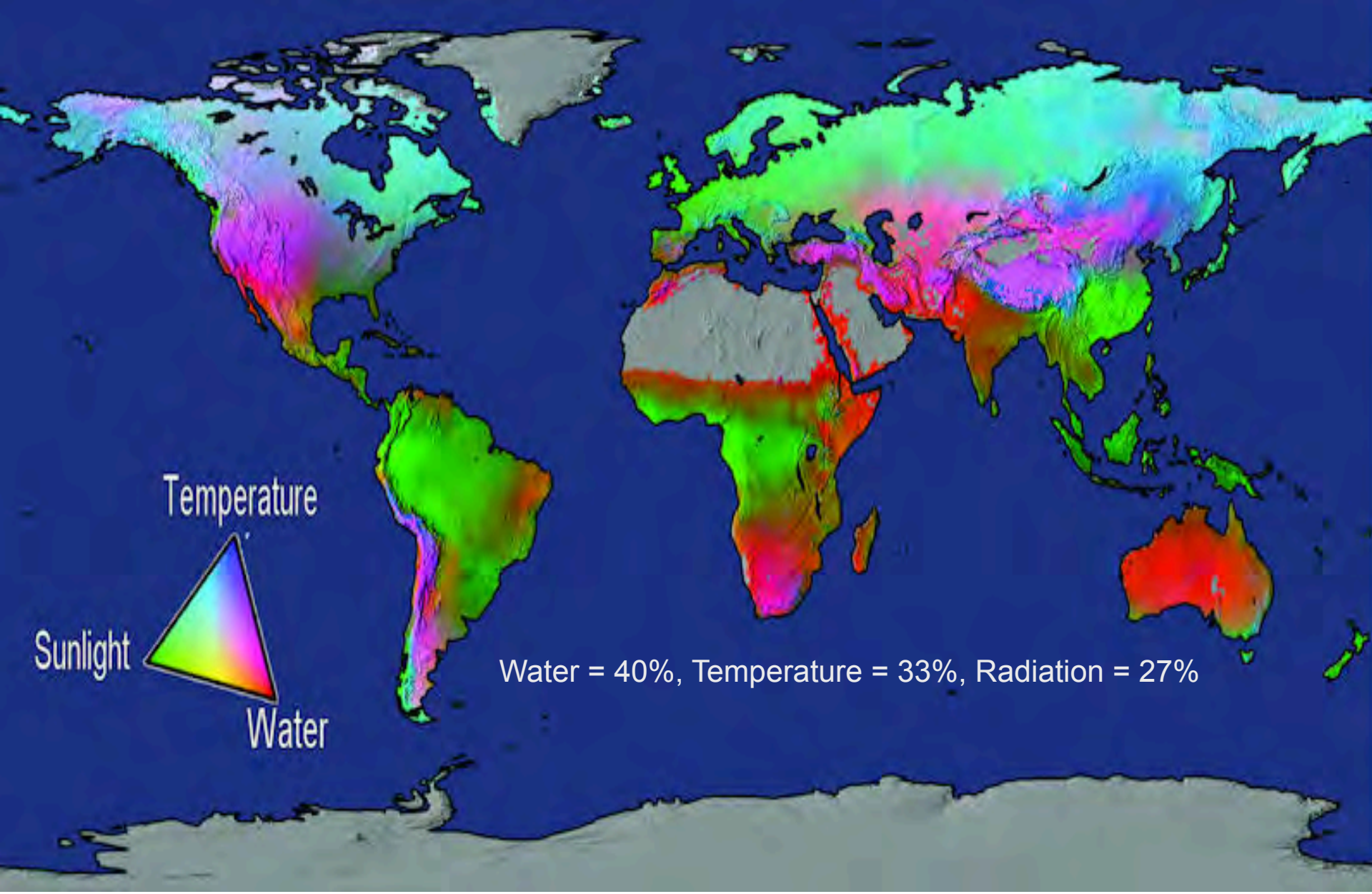
Source: Le Quéré et al 2013; CDIAC Data; Global Carbon Project 2013

Calculating global nutrient demand with MODIS NPP



Cleveland et al 2013, PNAS

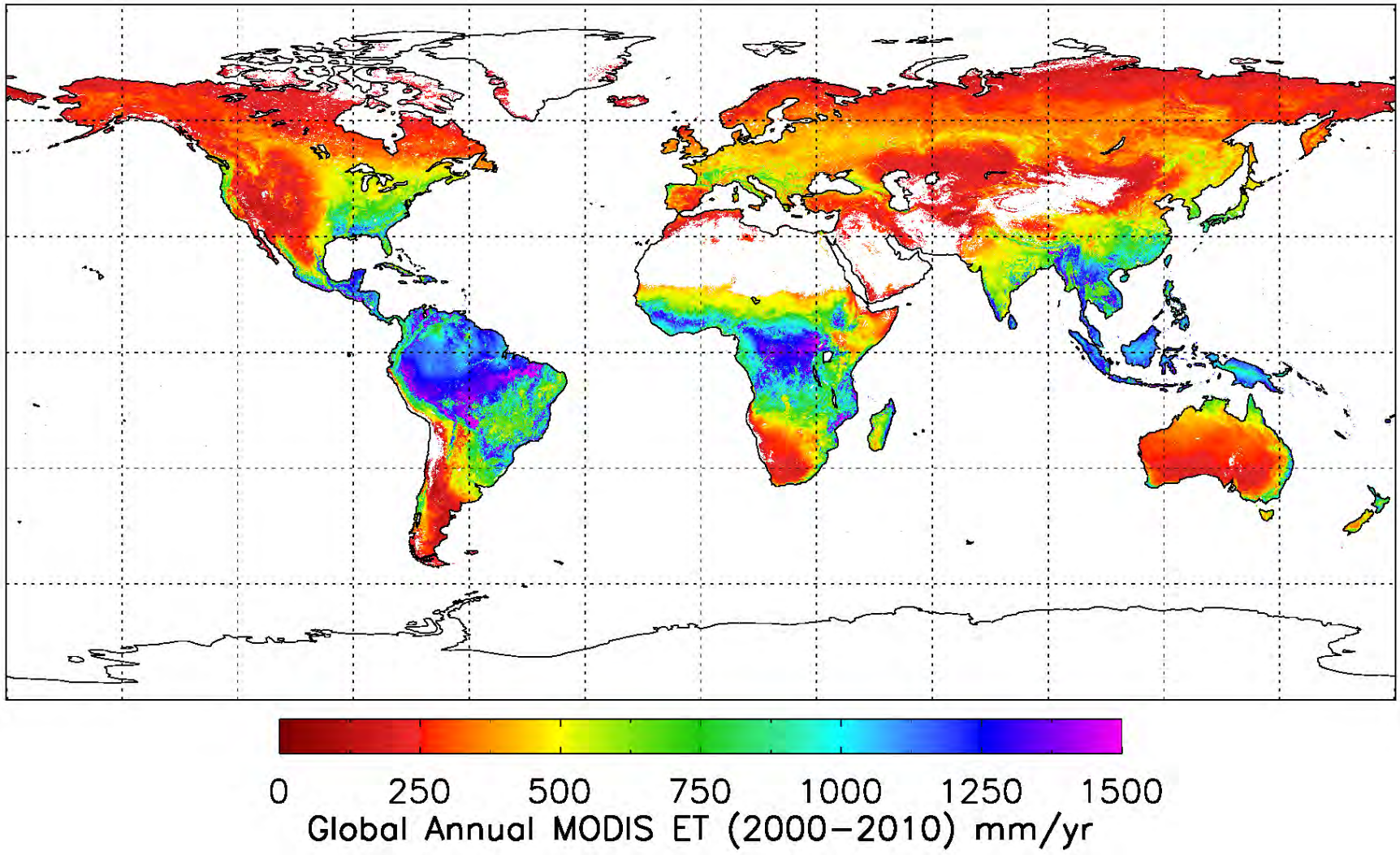
UMD_VEG_LC	ENF	EBF	DNF	DBF	MF	CShrub	OShrub	WSavanna	Savanna	Grass	Crop
LUEmax ($KgC/m^2/d/MJ$)	0.000962	0.001268	0.001086	0.001165	0.001051	0.001281	0.000841	0.001239	0.001206	0.000860	0.001044
Tmin_min (C)	-8.00	-8.00	-8.00	-6.00	-7.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00
Tmin_max (C)	8.31	9.09	10.44	9.94	9.50	8.61	8.80	11.39	11.39	12.02	12.02
VPD_min (Pa)	650.0	800.0	650.0	650.0	650.0	650.0	650.0	650.0	650.0	650.0	650.0
VPD_max (Pa)	4600.0	3100.0	2300.0	1650.0	2400.0	4700.0	4800.0	3200.0	3100.0	5300.0	4300.0
SLA (LAI/KgC)	14.1	25.9	15.5	21.8	21.5	9.0	11.5	27.4	27.1	37.5	30.4
Q_{10}*	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
froot_leaf_ratio	1.2	1.1	1.7	1.1	1.1	1.0	1.3	1.8	1.8	2.6	2.0
livewood_leaf_ratio	0.182	0.162	0.165	0.203	0.203	0.079	0.040	0.091	0.051	0.000	0.000
leaf_mr_base	0.00604	0.00604	0.00815	0.00778	0.00778	0.00869	0.00519	0.00869	0.00869	0.0098	0.0098
froot_mr_base	0.00519	0.00519	0.00519	0.00519	0.00519	0.00519	0.00519	0.00519	0.00519	0.00819	0.00819
livewood_mr_base	0.00397	0.00397	0.00397	0.00371	0.00371	0.00436	0.00218	0.00312	0.00100	0.00000	0.00000



Potential limits to vegetation net primary production based on fundamental physiological limits by solar radiation, water balance, and temperature (from Churkina & Running, 1998; Nemani et al., 2003; Running et al., 2004).

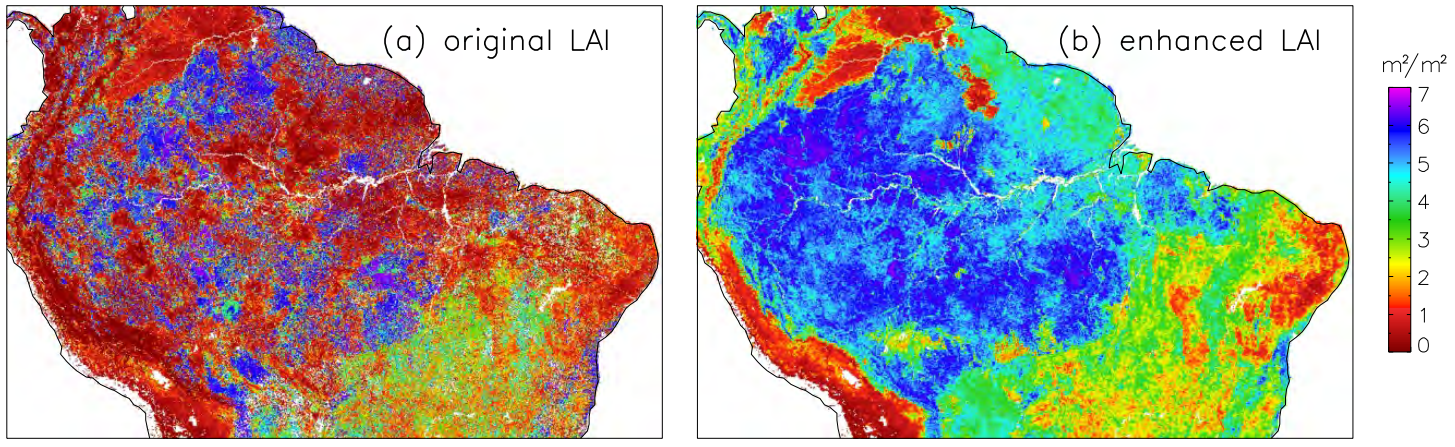
Global Annual 1-km ET over 2000-2010

Global average MODIS ET over vegetated land surface is 568.7 ± 358.2 mm yr^{-1}.



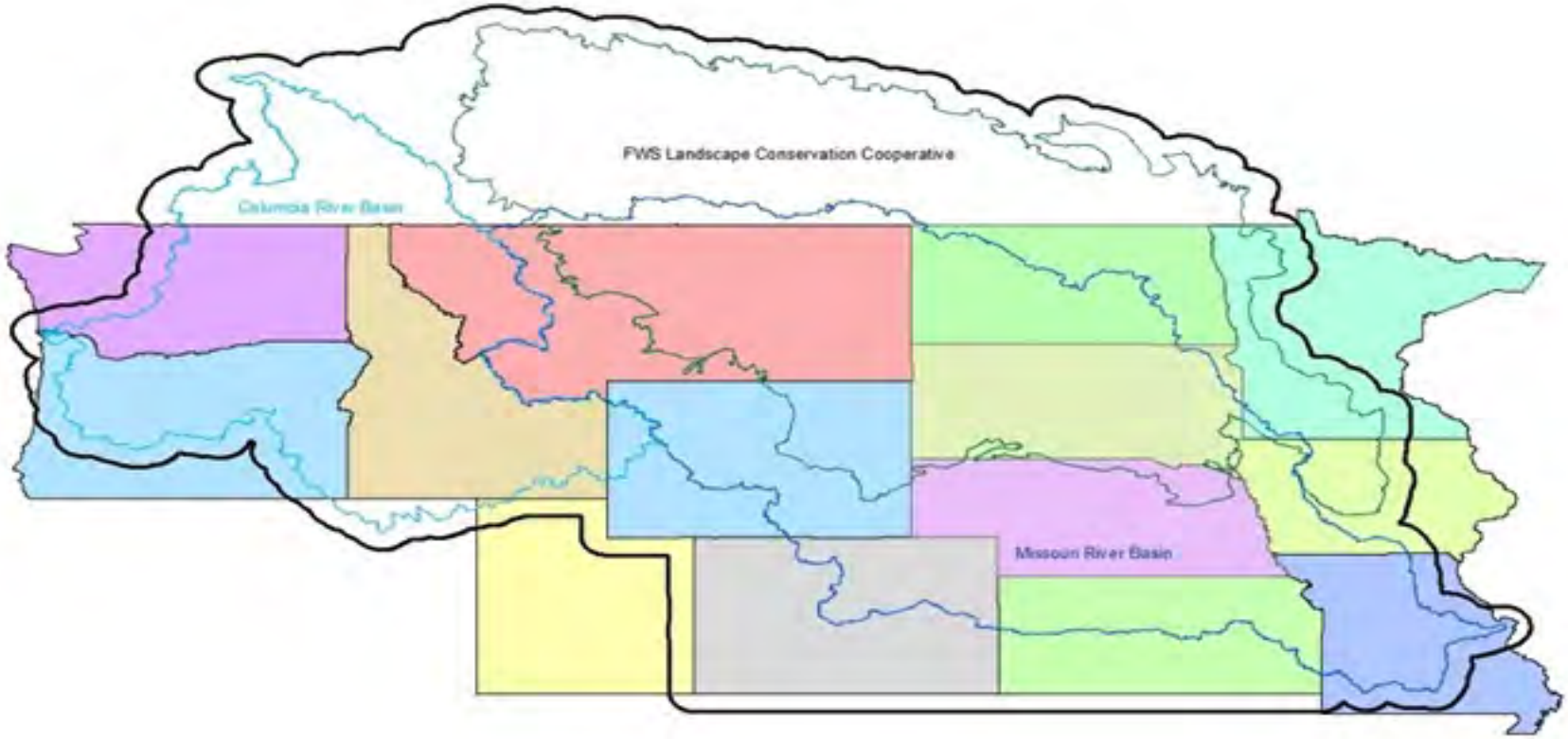
Preprocess Input Data

- MODIS data
  - temporally-filling gaps with contamination



- Global 1.00°X1.25° GMAO GEOS 5.7 and 0.5°X0.6° MERRA GMAO meteorological data
  - spatially interpolated data to the MODIS pixels

MOD 16/17 with 1km daily meteorology, with USGS



Global NPP 1983 version

Fig. 2. Global distribution of NPP (× 10 gm C/m²/yr) at the tracer model resolution.